SPACE TECHNOLOGY

Industrial and Commercial Applications

VOLUME 8 1988

VOLUME CONTENTS AND AUTHOR INDEX

PERGAMON PRESS Oxford · New York · Beijing · Frankfurt · São Paulo
Sydney · Tokyo · Toronto

SPACE TECHNOLOGY
Industrial and Commercial Applications
An International Journal

Editor-in-Chief
Professor L. G. NAPOLITANO
Institute of Aerodynamics, Naples University, P. le V Tecchio 80, 80125, Naples, Italy

Executive Editor
R. Monti, Institute of Aerodynamics, Naples University, Naples, Italy

Associate Editors
P. Castruccio, Ecosystem, PO Box 225, Gambrills, MD 21054, U.S.A.
B. J. Edelson, John Hopkins University, SAIS, Foreign Policy Institute, 1740 Massachusetts Avenue NW, Washington, DC 20036, U.S.A.
E. Galloway, 4612 29th Place NW, Washington, DC 20008, U.S.A.
G. Pardoe, General Technology Systems Ltd, Brunel Science Park, Kingston Lane, Uxbridge, Middlesex UB8 3PQ, U.K.
I. da Riva, Escuela de Ingenieros Aeronauticos, Ciudad Universitaria, Madrid 3, Spain
G. Seibert, ESA Headquarters, 8-10 Rue Mario Nikis, 75738 Paris, France

Editorial Advisory Board
D. Abir, Tel-Aviv University School of Engineering, Tel-Aviv 69978, Israel
E. V. Benton, Physics Dept, San Francisco University, San Francisco, CA 94117, U.S.A.
C. Buongiorno, Head, Space Office, Ministry of Science and Technology, Via Tahon de Revel 76, 00196 Rome, Italy
C. Ciliberto, Rector of Naples University, Naples, Italy
M. B. Collins, Department of Oceanography, The University, Southampton SO9 5NH, U.K.
H. Curien, 24 Rue de Sasset-S. Jacques, Paris 75005, France
S. Dahwan, ISRO Headquarters, Cauvery Bhavon, District Office Road, Bangalore 560 009, India
J. Fellows, British National Space Centre, R16 Building, Royal Aircraft Establishment, Farnborough, Hants GU14 6TD, U.K.
G. Greger, Ministry of Science & Technology, Postfach 20076, D-5300 Bonn 12, F.R.G.
L. Guerriero, Piano Spaziale Nazionale, Viale Regine Margherita 202, Roma, Italy
J. D. Hodge, International Management & Aerospace Consultants, 1105 Challedon Road, Great Falls, VA 22066, U.S.A.
C. de Jager, Laboratorium voor Ruimte-Onderzoek, Beneluxlaan 21, 3527 HS Utrecht, Netherlands
Y. Kuroda, Natn. Space Development Agency of Japan, World Trade Center Bldg., 2-4-0 Hamamatsu-Cho, Minato-ku, Tokyo 105, Japan
L. Laidet, CNES, 2 Place Maurice Quentin, 75039 Paris, France
A. Lebeau, 2, Avenue Jeanne d'Arc, Arcueil 94110, France
R. Malina, ISAST, 2020 Milvia Street, Berkeley, CA 94704, U.S.A.
H. Ochiai, Toba Merchant Marine College, Toba City, Mie-ken, Japan
W. L. Pritchard, Satellite Systems Engineering Inc., Suite 521E, 7315 Wisconsin Avenue, Washington, DC 20014, U.S.A.
A. Pryor, Director General, British National Space Centre, Room 803, Millbank Tower, London SW1P 4QU, U.K.
K. Serafimov, Central Laboratory for Space Research, BAN, 1 BD Russki, Sofiya 1000, Bulgaria
W. M. Strome, Vice President, Perceptron Computing Inc., 80 Bloor Street West, 11th Floor, Toronto, Ontario, Canada M5S 2V1
M. Trella, ESA Headquarters, 8–10 Rue Mario Nikis, F-75738 Paris Cedex 15, France
E. Vallerani, AERITALIA, Via E. Petrolini 2, 00197 Rome, Italy

Publishing Office: Journals Production Unit, Pergamon Press plc, Hennock Road, Marsh Barton, Exeter, Devon EX2 8NE, England (*Tel.* Exeter (0392) 51558; *Telex* 42749).

Subscription and Advertising Office: *North America*: Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, NY 10523, U.S.A.; *Rest of the World*: Pergamon Press plc, Headington Hill Hall, Oxford OX3 0BW, England (*Tel.* Oxford (0865) 64881).

Annual Subscription Rates 1989: Annual institutional subscription rate (1989) DM 425.00; 2-year institutional rate (1989/90) DM 807.50; personal subscription rate for those whose library subscribes at the regular rate (1989) DM 143.00. Prices are subject to amendment without notice.

Microform Subscription and Back Issues: Back issues of all previously published volumes are available direct from Pergamon Press. Back issues of all Pergamon journals in microform can be obtained from: UMI, 300 North Zeeb Road, Ann Arbor, MI 48106, U.S.A.

Published quarterly

Copyright © 1988 Pergamon Press plc

It is a condition of publication that manuscripts submitted to this journal have not been published and will not be simultaneously submitted or published elsewhere. By submitting a manuscript, the authors agree that the copyright for their article is transferred to the publisher if and when the article is accepted for publication. However, assignment of copyright is not required from authors who work for organizations which do not permit such assignment. The copyright covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microform or any other reproductions of similar nature and translations. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the copyright holder.

Photocopying information for users in the U.S.A. The Item-Fee Code for this publication indicates that authorization to photocopy items for internal or personal use is granted by the copyright holder for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided the stated fee for copying beyond that permitted by Section 107 or 108 of the US Copyright Law is paid. The appropriate remittance of $3.00 per copy per article is paid directly to the Copyright Clearance Center Inc., 27 Congress Street, Salem, MA 01970.

Permission for other use. The copyright owner's consent does not extend to copying for general distribution, for promotion, for creating new works or for resale. Specific written permission must be obtained from the publisher for such copying. *The Item-Fee Code for this publication is:* 0892-9270/88 $3.00 + 0.00

VOLUME CONTENTS

Volume 8, Number 1/2

COLUMBUS III: Proceedings of the Third Columbus Symposium

	v	Preface
C. Ciliberto	1	Welcome Address
Opening Addresses		
Gottfried Greger	3	Columbus, key element of the coherent European Space Programme
M. De Leo	5	Columbus project: technical and political interfaces

STATUS OF COLUMBUS PROGRAMME DEFINITION

F. Engström	9	Columbus, present programme status
Ernesto Vallerani and **Luigi D'Emiliano**	19	The pressurised modules, elements of cooperation and autonomy
H. Friedrich, A. J. Thirkettle and **H. G. Francois**	27	Man-tended free flyer configurations and servicing scenarios
P. J. Conchie and **E. P. L. Windsor**	37	Polar platform configuration and servicing
R. D. Andresen and **W. Nellessen**	45	EURECA in the Columbus scenario
K. Knott	59	Columbus payload accommodation aspects
C. Honvault	65	The ESA in-orbit infrastructure ground facilities concept

COLUMBUS UTILIZATION

Preparation		
J. J. Dordain	73	The potential of Columbus element utilisation
F. Rossitto and **F. Unz**	81	Columbus Phase-B utilization studies overview
Model Payloads		
David L. Croom	97	European Earth observation from the Space Station polar platforms
E. Kaldis	103	Critical aspects for the materials research under microgravity
Malcolm B. Wilkins	105	Columbus and the life sciences

L. G. Napolitano	111	Status and perspectives of microgravity fluid science
H. Olthof	121	Space science with Columbus—2
Reference Missions		
Jens Fromm, Wilfried Ley and **Franco Rossitto**	127	System utilization: European users' requirements analysis
Gustavo Oelker and **Alfio Allegra**	139	The utilization potential of the European Manned Space infrastructure
Karsten Huse	145	Man tended free flyer utilization aspects
C. P. Lee	151	The utilisation of the Columbus polar platform
A. Bielza and **A. Aldamiz**	159	Columbus utilization studies: attached payloads
Commercial Opportunities		
P. A. Kallenbach	163	Views on commercial payloads

PAYLOADS OPERATION

A. Sesma	167	Proposed guidelines for Columbus payload operation
Wubbo J. Ockels	175	Crew activities
A. Balogh	179	Interactive payload operations on Columbus: the application of telescience concepts
R. Monti	185	Gradual implementation of microgravity telescience: concept and operations
J. Howieson, W. van Leeuwen and **W. J. Ockels**	191	Crew work station test-bed
E. H. Classen and **R. H. Bentall**	195	Servicing support facilities
I. Hiller and **G. Naja**	205	Columbus utilization costs

INTERNATIONAL COOPERATION FOR UTILIZATION

L. Emiliani	209	International cooperation for utilization: the ESA viewpoint
Richard E. Halpern	213	The international Space Station complex: promise and problems
K. Higuchi and **T. Yamawaki**	221	Japanese Space Station Program
Parvez Kumar	229	Cooperative utilisation of the Space Station infrastructure: a Canadian viewpoint

I Appendix A—Scientific Programme

III Appendix B—List of Participants

Volume 8, Number 3

Robert Maxwell i Foreword

Radolfo Monti iii Tribute to the Editor-in-Chief—Professor Luigi G. Napolitano

Luigi G. Napolitano v MARS—an Italian center for research and support to microgravity experimentation

Charles H. Eldred and **Theodore A. Talay** 231 Prospects for advanced rocket-powered launch vehicles

R. S. Colladay and **S. R. Sadin** 239 Technologies for affordable access to space

Thomas L. Moser and **Jon D. Erickson** 249 The evolution of automation and robotics in manned spaceflight

Don N. Stitt, Robert J. Goss and **Peter E. Glaser** 261 Opportunities for commercial space power

Bettye B. Burkhalter and **George S. James** 267 Enhancing the quality of space education through program evaluation

F. Unz and **G. Oelker** 279 The European utilization programme for the Space Station

I New Patents

Volume 8, Number 4

Rainer Grün and **Horst Michaelis** 287 Future European ground segment

M. Mochizuki, E. Sogame and **Y. Shibato** 303 H-I and H-II launch vehicles

T. L. Labus and **T. H. Cochran** 319 Space Station electrical power system

V. N. Novikov and **D. N. Scheverov** 329 Formation of a space research program with the use of economic criteria

H. Lum and **E. Heer** 337 Progress towards autonomous, intelligent systems

S. A. Sarkisjan, S. S. Corunov, I. A. Starostin, A. G. Gurov, M. A. Carimulaev and **A. M. Mokritzin** 351 Socioeconomic benefits connected with the use of space power and energy systems

Nizar Sultan and **Paul Ng** 365 Multibeam frequency re-use mobile satellite system trade-offs

Zuwei Huang and **Xinmin Ren** 371 Long March launch vehicle family—current status and future development

A. F. Belov and **V. V. Nickolenko** 377 Behavior of alloys exhibiting shape memory effect at thermal cycling